

## **REMARKS**

### ***In the Drawings***

The drawings were objected to under 37 CFR 1.83(a) because they fail to show the timing/synchronization link 84 on Fig. 1, as described in the specification on page 6, lines 21-31.

An amended drawing has been submitted per the Examiner's instructions. Acceptance of the new drawing sheet for Fig. 1 and removal of the objection to the drawing is respectfully requested.

### ***In the Specification***

The first paragraph of the "Background of the Invention" section has been amended to correct a typographic error by replacing the word "principal" with the word "principle."

The last paragraph of page 6 in the "Detailed Description of the Invention" section has been amended to add the words "polarization or" prior to the words "phase modulators" in the last sentence of the paragraph, to make the sentence self-consistent.

### ***In the Claims***

Claim 1 has been amended to make the claim language more self-consistent. Thus, the term "light source" has been replaced with "optical radiation source," which is the preferred term as used in the specification (see, e.g., page 5, lines 10-13). Also, the phrase "when emitted" has been replaced by the word "outputted."

Claim 2 has been amended to clarify the antecedent basis of the term "optical radiation source" first used in claim 1.

Claim 3 has been amended to clear up a possible lack of antecedent basis

issue with the phrase “average number of photons” in the fourth line of the claim.

Claim 7 has been amended so that the phrase “light source” now reads “optical radiation source,” as is more consistent with the specification.

Claims 8 and 10 have been amended to correct typographic errors, and to clarify the point that the variable optical attenuator (VOA) is set **to a select value** by the controller. Also, in the third line of the claim, the phrase “capable of generating” has been replaced with “adapted to output” to make the claim language more consistent. Likewise, the word “output” in the next-to-last line of the claim has been replaced by “outputted.”

In claim 11, the word “emitted” has been changed to “outputted.” Claim 11 has also been amended so that it now depends from claim 10, as originally intended, rather than from claim 8.

### **Claim rejections under 35 USC 103**

All of the claims as originally presented were rejected under 35 USC 103(a) as being unpatentable for obviousness. Section 35 USC 103(a) reads as follows (emphasis added):

A patent may not be obtained though the invention is not identically disclosed or described as set forth in [section 102], if the differences between the subject matter sought to be patented and the prior art are such that the subject matter **as a whole** would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

According to MPEP 706.02(j), to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of

ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

In addition, when attempting to establish whether a claim is obvious or not, the claim must be read **as a whole**, as the statute directly states, i.e., not as collection of disconnected limitations. It is improper to use the claims as a roadmap to find the various limitations in the prior art in an effort to reconstruct the claim to formulate an "obviousness" rejection.

For the reasons discussed in detail below, the Examiner falls far short of establishing a *prima facie* case for obviousness for the pending claims. Firstly, neither the cited references nor the knowledge available to one of ordinary skill in the art provides all of the limitations of each claim. Further, for the limitations that were "found" in the prior art, there is no suggestion or motivation either in the references themselves or in the general knowledge of one skilled in the art to combine them in attempting to arrive at the claimed invention. This is because the claims were each **not read as a whole**. Instead, they were improperly read as **a collection of separate and unrelated limitations**, which were then used—again, improperly—to match passages in disparate and unrelated prior art in an effort to reconstruct the claims. The fact that the cited references actually **teach away** from Applicants' claimed invention supports this point.

#### Claims 1-7

Claims 1-7 were rejected under 35 USC 103(a) as being unpatentable over Townsend (U.S. Patent No. 5,953,421) in view of Sobolewski et al. (U.S. Patent No.

6,812,464 B1), further in view of Petrovic (U.S. Patent No. 6,683,958 B2).

In rejecting claims 1 thru 7, the Examiner relies heavily on Townsend as teaching a method of generating calibrated optical pulses in a QKD system. However, Townsend does not teach any kind of calibration method, or acts that could be reasonably construed as such. Rather, Townsend teaches a particular type of QKD system that has two single-photon-detector branches at the receiver (see, e.g., column 1, lines 28-39), and teaches a method of operating the system.

The first limitation of claim 1 of Applicant's patent application reads as follows:

sending first optical pulses having a fixed pulse width and a fixed power through a variable optical attenuator (VOA) for different VOA settings, and relating the respective transmitted powers of the first optical pulses to respective said VOA settings;

The various passages in Townsend cited by the Examiner have nothing to do with this limitation. Townsend, column 3, line 51 thru column 4, line 40, generally describes the **operation** (and not the **calibration**) of the QKD system of Fig. 1. The cited text discusses changes in the photon count rate both with and without an eavesdropper present. This type of change in photon count rate has nothing to do with calibrating optical pulses, but is a result of an eavesdropper trying to tap into the optical fiber and injecting replacement optical pulses into the optical fiber during operation of the system to hide his/her presence.

Townsend column 4, lines 41-60, and column 1, lines 51-55, is cited by the Examiner as disclosing the claim limitation relating to sending optical pulses of fixed power through the variable optical attenuator (VOA) for different VOA settings. However, the cited text does not even mention the attenuation of optical signals. Further, in FIG. 4, the attenuator (55) shown therein is properly understood by one skilled in the art to be a **fixed optical attenuator** (FOA) and **not a variable**

**attenuator** (VOA) because it is not coupled the microprocessor (50) to effectuate changes in attenuation. Thus, Townsend actually **teaches away** from the use of a VOA. This is further supported by the fact that there is simply **teaching or suggestion** in the cited text— or indeed **anywhere** in Townsend—about sending optical pulses of fixed power through a VOA and varying the attenuation of the VOA to perform a **calibration** of the optical pulses, as claim 1 requires.

The Examiner also cites column 1, lines 50-57, and column 3, line 51 to column 4, line 50 as covering the claim limitation of “relating respective transmitted powers of the first optical pulses to respective said VOA settings.” However, the cited text does relate to this claim limitation in the least. The text in column 1, lines 50-57, makes the point that the attenuation is to be set to a level where the average number of photons (i.e., the mean photon number) is considerably less than one. This is properly understood to mean that **during normal operation of the QKD system** of Fig. 4, the **fixed** attenuation needs to result in an average number of photons being considerably less than one. This is a re-statement of a well-known fact that any QKD system operates with optical signals having an average of one photon per pulse or less. As such, this statement has no bearing on the limitations in claim 1 whatsoever.

Further, as mentioned above, the text in column 3, line 51, through column 4, line 40, discusses the general operation of the QKD system with and without an eavesdropper present, and does not teach or suggest the limitation of “relating respective transmitted powers of the first optical pulses to respective said VOA settings.” What is discussed in the cited text is the relationship between the number of photon counts made by the single-photon detectors as a function of the change in mean photon number of the optical pulses injected into the system by the eavesdropper. This is a completely different and an entirely unrelated process to the act of “relating respective transmitted powers of the first optical pulses to respective said VOA settings,” as is claimed. Again, when viewed in the context of the invention and the claim as a whole, it becomes immediately apparent that the act of relating

transmitted powers to VOA settings ***cannot be accomplished with single photon detectors.***

The Examiner cites column 1, lines 51-55, for disclosing the claim limitation of “setting the VOA to maximum attenuation.” Again, this cannot be correct because Townsend includes a ***fixed optical attenuator (FOA)*** and thus ***teaches away*** from using a ***variable attenuator (VOA)***. Further, the cited text simply states that “...the attenuation is set to levels sufficient to make it highly unlikely that more than one photon would be present in any given time slot.” Thus, *arguendo*, even if the attenuator in Townsend were a VOA, it does not follow from the cited text that the attenuator setting is the ***maximum*** attenuation setting, as claimed. In fact, any one of a number of settings of a VOA would accomplish this. Further, and to re-emphasize the point made above, the cited language is ***not provided in the context of calibrating*** the QKD system, but rather is in the context of ***actually running*** the QKD system.

The Abstract of Townsend is cited as disclosing the limitation in claim 1 of “directing second optical pulses having varying pulse widths through the VOA and relating respective transmitted powers of the second optical pulses to their respective varying pulse widths.” However, a careful reading of the Abstract reveals that it only mentions that a “highly attenuated source” is used to generate single-photon signals in the operation of the QKD system. There is no ***teaching or suggestion*** of measuring transmitted powers of the optical pulses to the respective pulse widths when passing the pulses through a VOA set to the maximum attenuation. In fact, the Abstract states that the optical signals are detected as coincident signals to calculate a rate of detection of single-photon signals using single-photon detectors. As single-photon detectors do not detect power but rather the arrival or non-arrival of an optical signal regardless of the number of photons, the Abstract actually ***teaches away*** from measuring optical power in a ***calibration process*** that involves “relating respective transmitted powers of the second optical pulses to their respective varying pulse widths,” as required by claim 1.

Claim 1 also includes the limitation of “automatically setting the VOA to the calibrated attenuation setting.” Again, Townsend actually **teaches away** from this because it has a fixed optical attenuator, and not a VOA. Further, *arguendo*, even if the attenuator were a VOA, it is not connected to the microprocessor and so cannot be automatically set. Further, the cited text in Townsend in column 1, lines 50-56, does not refer to a **calibrated** setting, but rather to **any operational setting** “sufficient to make it highly unlikely that more than one photon would be present in any given time slot.” The number of attenuations that can do this is, in principle, infinite since the attenuation need only keep the average photon count less than one. In other words, different attenuations corresponding to average photon numbers of 0.9, 0.8, 0.7, 0.6, etc., would all be “sufficient” attenuations according to Townsend. Applicants claimed invention, on the other hand, requires that the attenuation be set to a **calibrated** setting.

The reasoning set forth above applies in like fashion to claims 5 and 7. Applicant therefore respectfully submits that the Examiner has failed to establish a *prima facie* case for obviousness for claims 1, 5 and 7 (and consequently the claims depending therefrom) because Townsend cannot reasonably be said to include the aforementioned limitations in claims 1, 5 and 7. In fact, Townsend actually **teaches away** from the claimed invention, so that the use of Townsend in establishing a *prima facie* case for obviousness is improper. This becomes eminently clear when each claim is read as a whole and in the context of the claimed invention, namely an optical pulse calibration method for QKD.

In view of the above, the need to address the Sobolewski and Petrovic references is moot, as is the need to address the rejections of dependent claims 2, 3, 4 and 6. Applicants respectfully submit the rejection of claims 1-7 is traversed and kindly request that claims 1-7 be allowed.

### Claims 8, 9 and 11

Claims 8, 9 and 11 were rejected under 35 USC 103(a) as being unpatentable over Bennett (U.S. Patent No. 5,307,410) in view of Sobolewski and Petrovic. Claim 11 has been amended to depend from claim 10. As mentioned above, claims 8 and 10 have been amended to clarify the point that the VOA is automatically set to **a select attenuation value**.

### **Claims 8 and 9**

The Examiner also cites Bennett, column 4, lines 49-68, for the claim limitation of “wherein the VOA is automatically set by the controller using a calibration table stored therein.” The relevant portion of the cited text states that “the attenuator is set to one value during the distribution of cryptographic key information,” and that “the variable attenuator 32 is set to a second value during calibration of a **key receiver**” (emphasis added). Note that the only mention of “calibration” in Bennett is in connection with calibrating the **key receiver**, and **not** for calibrating **optical pulses**. There is no teaching or suggestion in the cited text—or elsewhere in Bennett— of **selectively** setting the degree of attenuation during or in anticipation of initiating the key exchange process based on a **calibration table** in order to produce **calibrated optical pulses**.

The cited text states the basic proposition that the attenuation needs to be such that the optical pulses have an average photon number of one or less when the performing key exchange. The invention of claim 8 improves upon this basic idea by requiring that the attenuator not just be set to **any value** that enables performing key exchange, but set to a **select value** that provides **calibrated optical pulses** that allow for an efficient key exchange process (see Applicants’ specification, page 9, lines 10-13). Claim 8 has been amended to clarify this point.

Claim 8 further requires that the controller use “an average power expected at the receiver in the second station...” In this regard, it is important to remember that each claim needs to be read as a whole and in context, and not used as a roadmap to

find the limitations in the prior art. The “average power expected at the receiver” limitation needs to be read and understood as being part of the “calibration table” limitation, and understood in the context of the claim, which is directed to producing **calibrated pulses** via the calibration table and the expected average power when operating a one-way QKD system.

The Examiner cites Sobolewski, Abstract, column 8, line 64 to column 9, line 65, and Fig. 5, as disclosing the claim limitation relating to the “average power,” and then attempts to tie this limitation to Bennett.

Sobolewski is directed to a single-photon detector that could be used in quantum cryptography to detect single photons. Applicants readily admit that it is known in the art that detectors can be used to determine an average power per optical pulse. This single fact cannot be viewed in a vacuum and then applied to the claimed invention.

As can be seen from a careful reading of the last paragraph of claim 8, the invention is more than just measuring an average power. It is a calibration process that involves many steps that need to be read as a whole, namely (1) automatically (2) setting the VOA (3) to a select value (4) using a calibration table and (5) an average power expected at a receiver (5) in order to produce calibrated pulses outputted by the optical radiation source. Neither Sobolewski, nor any of the other cited references, taken alone or in combination, teach, suggest or provide motivation for carrying out these steps in the context of providing calibrated optical pulses in the manner claimed.

In view of the above, Applicants respectfully submit that the Examiner has failed to make a *prima facie* case for obviousness because the not all of the claim limitations are taught or suggested by either the prior art or by knowledge generally available to one skilled in the art. Consequently, the rejections to claim 8, and to claim 9 depending therefrom, are traversed, and the Applicants kindly request the

allowance of these claims as presented herein.

#### Claims 10 and 11

Claim 10 was rejected under 35 USC 103(a) as being unpatentable over Gisin et al. (U.S. Patent No. 6,438,234) in view of Sobolewski and Petrovic. Claim 10 has been amended to clarify the point that the VOA is set to **a select attenuation value** by the controller.

The Examiner notes that Gisin does not disclose the limitation of automatically setting the VOA by the controller using a stored calibration table and an average power expected at the receiving detector. The Examiner relies on Bennett for the “calibration table” limitation and relies on Sobolewski for the “average power” limitation, in the same manner as with claim 8, discussed above.

The same arguments set forth in connection with the application of Bennett and Sobolewski to claim 8 apply here equally to claim 10. To reiterate briefly, there is no teaching or suggestion in Bennett, or in the general knowledge in the art of using a calibration table, and no teaching or suggestion in either Sobolewski or Bennett, or in the general knowledge in the art, for generating calibrated pulses using a calibration table and an average power expected at the receiver. Accordingly, the cited references do not provide all of the claim limitations in claim 10.

In view of the above, Applicants respectfully submit that the Examiner has failed to make a *prima facie* case in rejecting claim 10 for obviousness. Accordingly, the Applicants respectfully submit that the rejection to claim 10 is traversed, and respectfully request the allowance of claim 10, as well as claim 11 now depending therefrom.

### CONCLUSION

Acceptance of the amendments to the drawings, the specification and the claims for the reasons stated above is kindly requested.

Applicants respectfully submit that a *prima facie* case of obviousness for the pending claims has not been made, and that the arguments set forth above traverse the rejections. Accordingly, it is respectfully submitted that the claims are allowable as presented herein. A prompt issuance of a Notice of Allowance with respect to all of the pending claims is therefore kindly requested.

The Applicants thank the Examiner for pointing out the needed correction to the drawing of FIG. 1, and for the helpful instructions for correcting same.

The examiner is encouraged to contact the Assignee's authorized representative at 941-923-6844 to discuss any questions that may arise in connection with this Response.

Respectfully Submitted,

Date: May 03, 2005

By: Joseph E. Gortych  
Joseph E. Gortych  
Reg. No. 41, 791

